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**Predation of Water Bug *Sphaerodema rusticum* on the Freshwater Snails *Lymnaea (Radix) luteola* and *Physa acuta***

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The freshwater snails *Lymnaea (Radix) luteola* Lamarck, 1822, and *Physa acuta* Draparnaud, 1805, are found side by side in nature where they are occurring. It is practically impossible to distinguish them at a glance. The water bug *Sphaerodema rusticum* Fabr. preys upon both the snail species (Raut et al., 1988; Aditya & Raut, in press). Since the prey individuals are of similar type with respect to their shell contour and size, the aim of this study was to determine whether the water bug *Sphaerodema rusticum* has preference for either of the species and, if so, whether the water bug is able to select the individuals belonging to the preferred prey species when both the prey species are found together. The snail *L. (R.) luteola* is involved in the spread of worm diseases in man and animals (Raut, 1986, 1991; Subba Rao, 1989; Mukhopadhyay, 1991; Srivastava, 1991; Subba Rao & Mitra, 1991), and *P. acuta* is causing serious problems in sewage purification plants (Macha, 1971). Attempts are being made to control these snails through the use of biological agents. Therefore, the findings of the present study will enable us to gain some knowledge on the effective use of the water bug *S. rusticum* to control the snails *L. (R.) luteola* and *P. acuta*.

## Materials and Methods

A large number of *L. (R.) luteola* and *P. acuta* 6-7 mm in shell length were collected from the municipality

drains in Kolkata, India. The adult morphs of the water bug *S. rusticum* were also collected from the same drain simultaneously. They were kept in the laboratory in pond water, in plastic containers. The snails were fed with lettuce regularly for a period of 7 days. The water bugs were allowed to feed on the snails kept in the containers. After 1 week, the following experiments were performed to note the rate of predation of *S. rusticum* on the prey individuals supplied.

- Experiment I. 40 *L. (R.) luteola* were exposed to an adult *S. rusticum*.
- Experiment II. 40 *P. acuta* were exposed to an adult *S. rusticum*.
- Experiment III. 40 prey individuals (20 *L. (R.) luteola* and 20 *P. acuta*) were exposed to an adult *S. rusticum*.

The same-sized *L. (R.) luteola* and *P. acuta* were almost equal in weight.

Experiments were carried out in plastic containers, each 25 cm in diameter and 8 cm in depth, containing 2.5 L pond water. All the experiments were carried out for 7 consecutive days. Experiments with the single prey species were repeated three times, while those with the combination of two prey species were repeated six times. Data were collected on the number of snails consumed completely (except the shell) and partially, at the end of each 24 hour period. The water in the container was replaced by fresh pond water, and the prey snail individuals, as per specification were released into the container every 24 hours. In all cases, mean and standard error ( $\pm$  SE) were calculated. Analysis of variance (ANOVA) was applied (Campbell, 1989) to ascertain whether the rate of predation differed significantly with the prey species, singly, or in combinations of the two, or not.

## Results

## Experiment I

In 21 trials the adult *S. rusticum* killed a total of 262 *L. (R.) luteola*. Of these, 179 (68.32%) and 83 (31.68%) were devoured completely and partially, respectively, by the water bug. The water bug killed 8-18 (average  $12.48 \pm 0.65$ ) individuals per day. The number of completely and partially consumed individuals ranged from 6-10 (average  $8.52 \pm 0.31$ ) and 0-9 (average  $3.96 \pm 0.51$ ) per day (Figure 1), respectively.

## Experiment II

The water bug killed a total of 217 *P. acuta* in 21 trials in 7 days. The number of completely and partially devoured individuals was 82 (37.79%) and 135 (62.21%), respectively. The daily rate of predation ranged from 7-16 (average  $10.33 \pm 0.56$ ). Of these, 0-10 (average  $3.9 \pm 0.45$ ) and 2-14 (average  $6.43 \pm 0.7$ ) individuals were

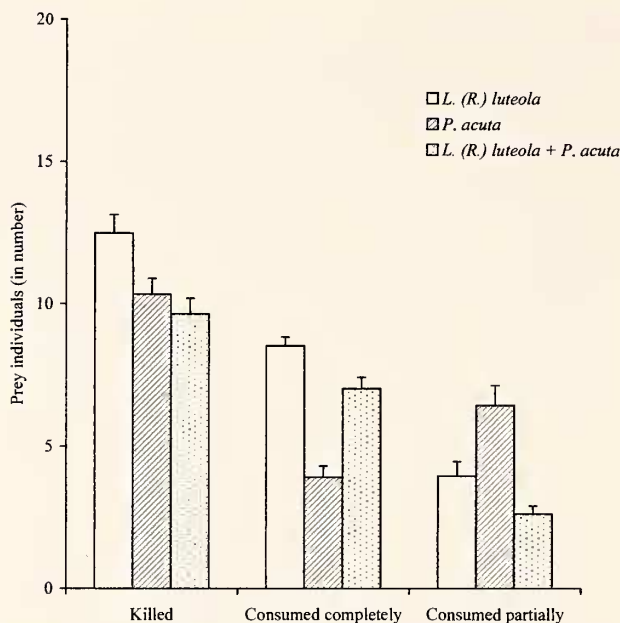


Figure 1. The number (mean  $\pm$  SE) of prey individuals belonging to *L. (R.) luteola* and *P. acuta* killed, completely consumed, and partially consumed per day (24 hours) by an adult *S. rusticum* (40 individuals of each prey species were supplied separately for 24 hours).

devoured completely and partially, respectively (Figure 1).

### Experiment III

Irrespective of prey species, a total of 405 individuals were killed by the water bug in 42 trials. Of these, 295 (72.84%) and 110 (27.16%) individuals were devoured completely and partially, respectively. The daily rate of predation, irrespective of prey species, ranged from 4–19 (average  $9.64 \pm 0.55$ ), and the number of completely and partially consumed individuals ranged from 4–14 (average  $7.02 \pm 0.4$ ) and 0–11 (average  $2.62 \pm 0.28$ ) per day, respectively (Figure 1).

Analysis of the data revealed that the water bug killed 263 *L. (R.) luteola* and 142 *P. acuta* in 42 trials. Of the 263 *L. (R.) luteola*, 229 (87.07%) and 34 (12.93%) were consumed completely and partially, respectively. The water bug consumed 66 (46.48%) and 76 (53.52%) *P. acuta* completely and partially, respectively. A comparative account of the rate of kill and consumption, completely and/or partially by the water bug is shown in Figure 2.

ANOVA tests clearly revealed no significant difference in the rate of predation in terms of killing of the prey individuals per day by *S. rusticum* between the prey snail species *L. (R.) luteola* and *P. acuta*. However, the rate of complete consumption of the prey individuals by the predator differs significantly ( $P < 0.01$ ) with the prey species. Similarly, the difference in partially fed individ-

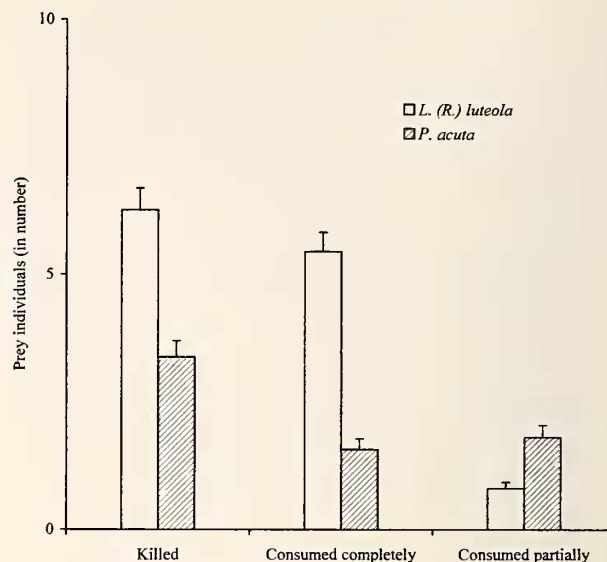


Figure 2. The number (mean  $\pm$  SE) of *L. (R.) luteola* and *P. acuta* killed, completely consumed, and partially consumed by an adult *S. rusticum* per day (24 hours) when 20 *L. (R.) luteola* and 20 *P. acuta* were supplied together.

uals between the prey species is statistically significant ( $P < 0.01$ ). In *L. (R.) luteola* the difference in the number of completely and partially consumed individuals is statistically significant ( $P < 0.01$ ). In the case of *P. acuta*, however, such differences are insignificant. The water bug, while exposed to both the prey species, killed a varying number of individuals with respect to species. Such variations are statistically significant ( $P < 0.01$ ) as is evident from the results of ANOVA tests. Also, the variations in the rate of completely consumed ( $P < 0.001$ ) and partially consumed ( $P < 0.05$ ) prey individuals are statistically significant with respect to the prey species concerned.

### Discussion

The water bug *S. rusticum* killed on an average 12.48 and 10.33 *L. (R.) luteola* and *P. acuta*, respectively, when they were supplied separately in equal numbers daily. Although the rate of killing of the prey snails varied with the treatment, such variations are statistically insignificant. Therefore, it appears that both species of prey snail were almost equally acceptable to the water bug *S. rusticum*. However, it appears that *S. rusticum* is sensitive to the quality of the food materials of the snail species concerned. It consumed 68.27% and 37.75% of the captured (killed) *L. (R.) luteola* and *P. acuta* completely, respectively, daily when predation was confined to the individuals belonging to a single prey species. It is difficult to accept the idea that the quantity of food present in an individual *P. acuta* is double the amount contained in a same-sized (equal weight) *L. (R.) luteola*. If that were the

case, why did the predator feed on 62.25% *P. acuta* partially? In the case of predation on both prey species, *S. rusticum* killed 6.26 *L. (R.) luteola* and 3.38 *P. acuta* per day. Since there were 40 prey individuals, 20 *L. (R.) luteola* and 20 *P. acuta*, the water bug would have consumed only *L. (R.) luteola* to satisfy its needs. In reality, it killed 6.26 and 3.38, and consumed 5.45 and 1.57 *L. (R.) luteola* and *P. acuta* individuals completely, respectively, daily. As the water bug consumed 1.57 *P. acuta* in contrast to 5.45 *L. (R.) luteola* completely, the possibility of selection of the prey individuals by *S. rusticum* prior to capture is very remote. If that were the case, there would have been no chance of victimization of *P. acuta* by *S. rusticum*. The results show that *S. rusticum* was reluctant to swallow the flesh of *P. acuta*. Therefore, it is not expected that the water bugs would spend energy unnecessarily to capture and handle *P. acuta*. In reality this did occur. Thus, it seems that the water bug was unable to recognize the prey individuals with respect to the species under reference. This again raises the question of the swallowing of the snail *P. acuta*. If *P. acuta* were captured by mistake, then it would be expected that the water bug would refuse the same, when it became known because of taste that the prey was not *L. (R.) luteola*. But we have cases where *S. rusticum* devoured the flesh of *P. acuta* completely. However, this was not a case of parallel choice of the prey individual *P. acuta* with respect to *L. (R.) luteola*, but more likely a feeding choice to satisfy hunger and ensure survival.

However, whatever the degree of preference for the prey snails, *L. (R.) luteola* and *P. acuta*, the water bug *S. rusticum* would prove effective in killing both prey species at an almost equal rate in a natural population, be it a single prey species population or a mixed population of both species. Therefore, consideration should be given to employing *S. rusticum* to control the snails *L. (R.) luteola* and *P. acuta* with a view to minimizing the hazards associated with these species (Macha, 1971; Raut, 1986; Subba Rao, 1989; Srivastava, 1991).

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#### Two Genera of North American Freshwater Snails: *Marstonia* Baker, 1926, Resurrected to Generic Status, and *Floridobia*, New Genus (Prosobranchia: Hydrobiidae: Nymphophilinae)

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Herein we recognize two genera of North American freshwater snails of the hydrobiid subfamily Nymphophilinae. One genus is resurrected from the synonymy of *Pyrgulopsis* Call & Pilsbry, 1886, while the other is newly proposed to accommodate species from the eastern United States previously placed in the genus *Cincinnatia* Pilsbry, 1891.

Baker (1926) proposed *Marstonia* as a subgenus of *Amnicola* Gould & Haldeman, 1840, containing *A. lustrica* Pilsbry, 1890. Subsequently Baker (1928) added seven other species (all from northeastern North America) to this group, all of which are either currently placed in other genera or are fossils that are not readily assignable to genus. Berry (1943) showed that the penes of *Amnicola* and *Marstonia* differ in terms of internal ducts (and other features), and Morrison (1949) implied that these taxa should be placed in separate subfamilies of Hydrobiidae on this basis. Thompson (1970) redefined *Marstonia* and restricted it to the type species and one (new) species from the southeastern United States. Thompson (1977) subsequently expanded *Marstonia* to include six other eastern North American species which he described in detail. He noted the close morphological similarity between *Marstonia* and eastern species of *Pyrgulopsis*, but continued to recognize these as separate genera pending